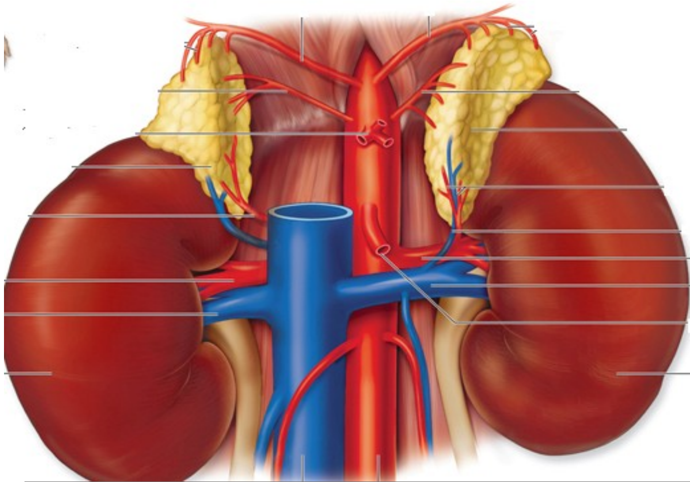
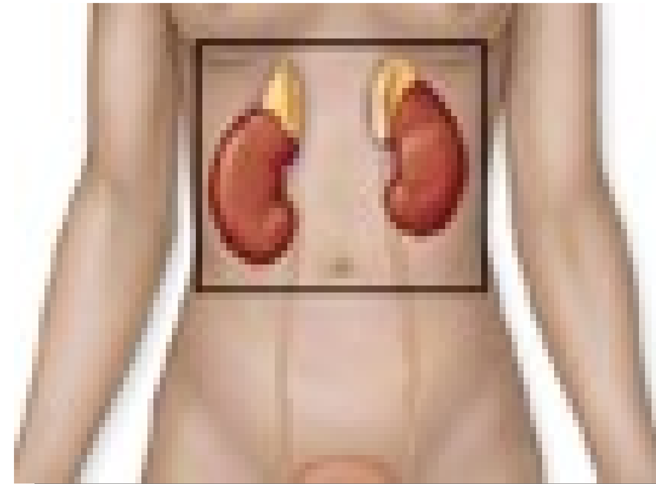
Armed Forces College of Medicine

AFCM





Physiology of adrenal glands (2)

By

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INTENDED LEARNING OBJECTIVES (ILO)

- **By the end of this lecture (2), the student will be able to:**

1- Identify the physiological actions of cortisol hormone.

2- Explain the diabetogenic effect of cortisol.

3- Summarize the control system for cortisol.

4- List the hormones that are released during stress.

5-Identify the manifestations of over-secretion of glucocorticoids..

Glucoocorticoids

(Cortisol)

- They are essential for life.

1- Site of release:

- They are secreted by the zona fasciculata of adrenal cortex.
- Cortisol is the most potent & main GC (> 95%). (corticosterone also is secreted).

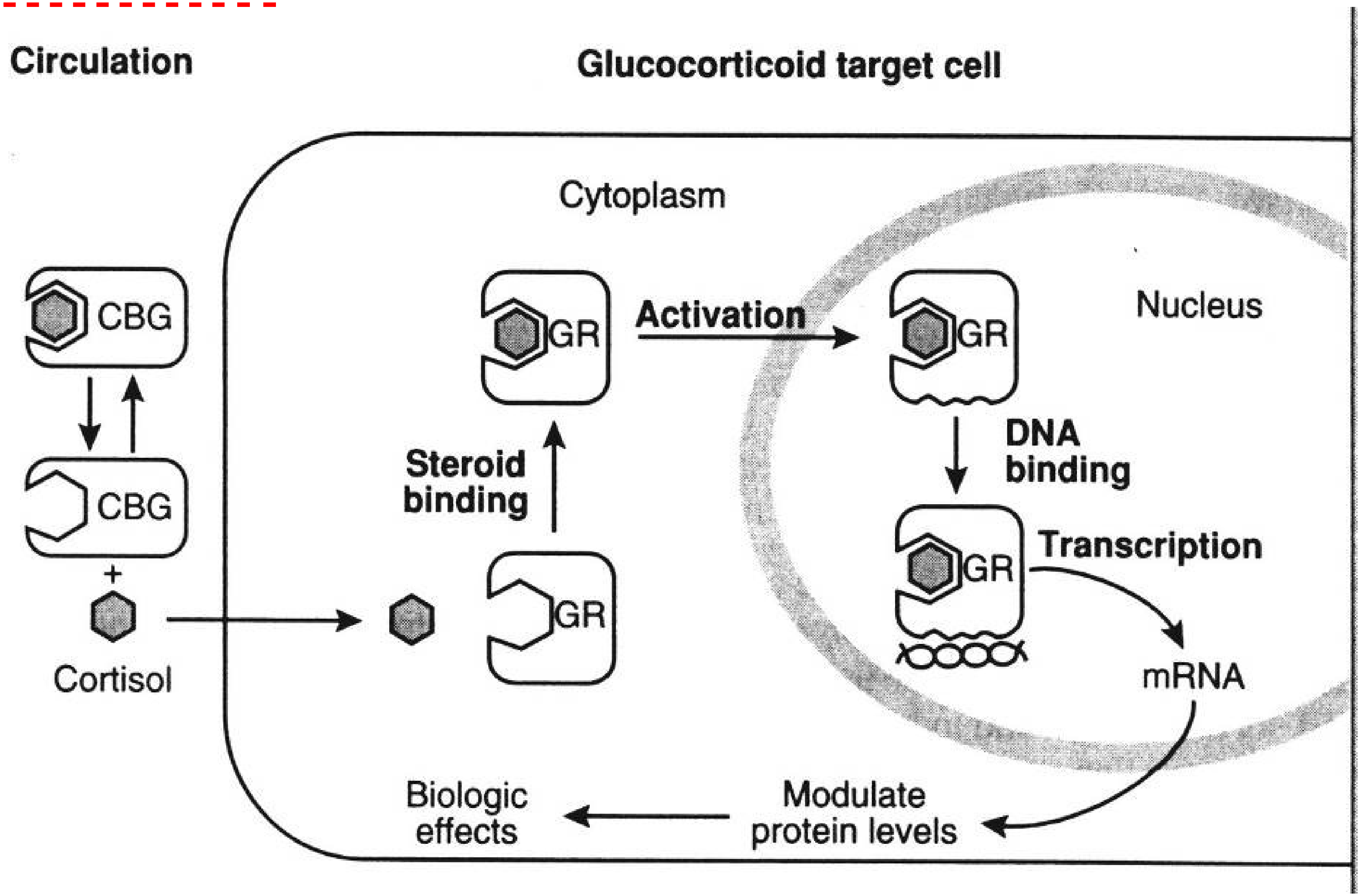
2- Nature:

- It is a steroid hormone.

3- Normal level:

13.5 μg/dL

4- Mechanism of action:



5- Physiological actions:

1- On metabolism:

- *On **carbohydrate** metabolism.*

  - (+) of **gluconeogenesis** by the liver

     hepatic glucose output.

  - ↓ glucose utilization of by muscle & adipose tissue (anti-insulin effect).

- Both effects ↑ in blood glucose level adrenal diabetes.
- So cortisol is **HYPERGLYCEMIC** hormone.

- ***On protein metabolism:***

- ↑ **Extrahepatic** protein catabolism (e.g muscles, bone matrix, lymphoid tissue, skin).
- So cortisol is a **CATABOLIC** hormone.

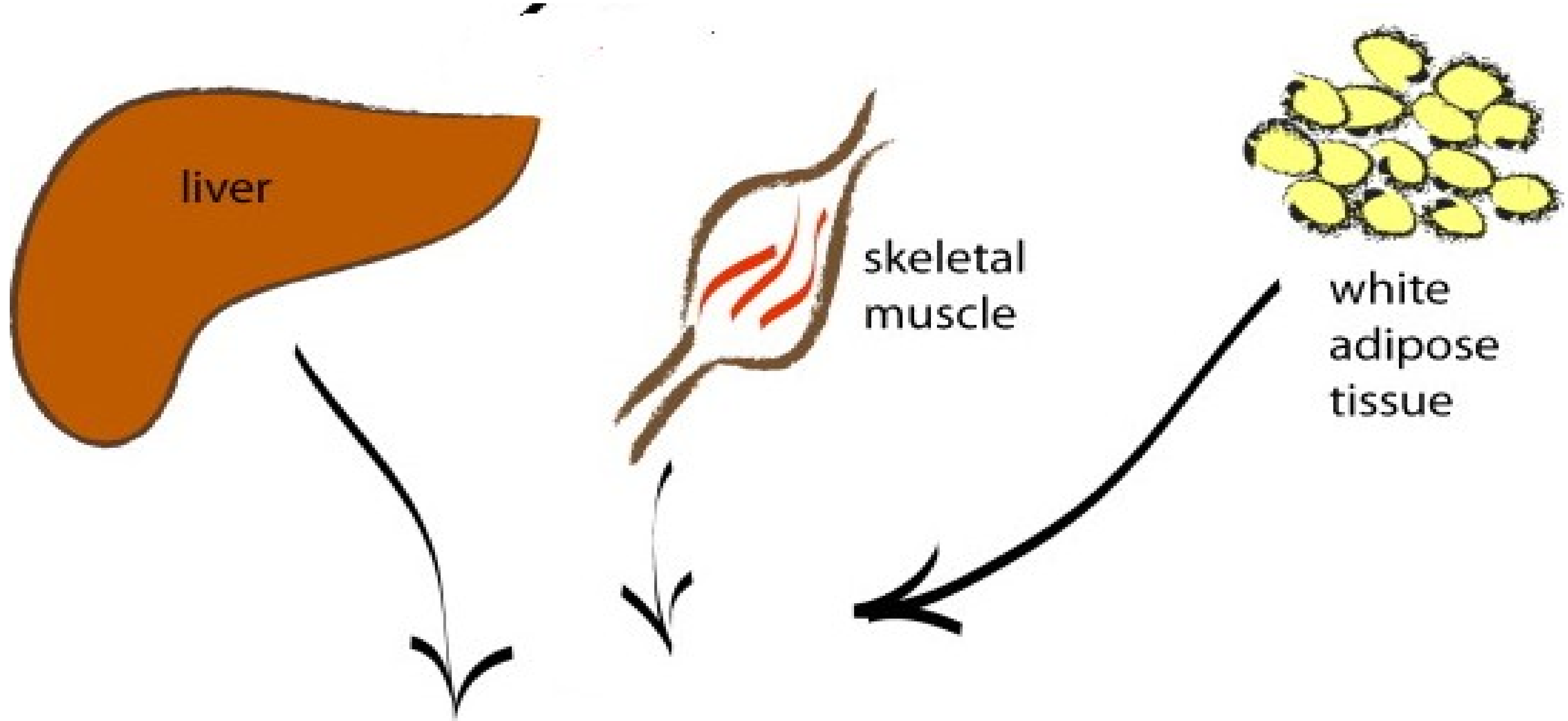
- ***On fat metabolism:***

- Cortisol (+) lipolysis by (+) of HSL.

 mobilization of **fatty acids** from adipose tissue & their oxidation to be used as alternative fuel so sparing glucose for the brain.

 provide **glycerol** to the liver for gluconeogensis.

- So cortisol is a **LIPOLYTIC** hormone.



↑ blood glucose.

↑ blood amino a

↑ blood fatty aci

Hyperglycemic

Lipolytic

Catabolic

2- <u>Permissive action</u>:

Small amounts of cortisol must be present to allow some actions of other hormones to reach their full effect.

e.g.

- Cortisol permit the **catecholamines** to induce <u>vasoconstriction</u>, <u>liypolysis</u> and <u>bronchodilation</u>.

- The permissive effect of cortisol is also needed for **glucagon** to produce its <u>lipolytic</u> effect.

So cortisol is needed for some actions of catecholamines and glucagon.

3- <u>On C.N.S</u>:

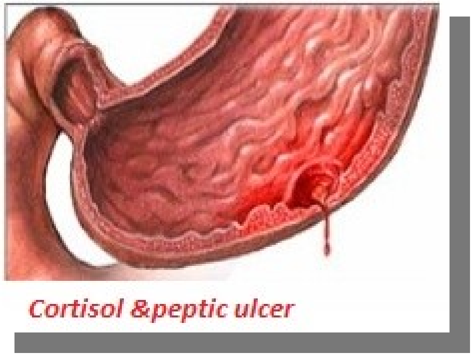
- Maintains normal neuronal excitability
- ↑↑↑ **euphoria.**

4- <u>On C.V.S</u>:

- ↑ sensitivity of vascular smooth muscles to catecholamines.
- ↑↑↑ ↑ **arterial blood pressure.**

5- <u>On GIT</u>:

- ↓ mucosal cell proliferation & mucous secret
- ↑ gastric acid secretion
   peptic ulcer.



6- <u>On Kidney:</u>

- ↑ **GFR .**
  ↓ **ADH.**   } **Diuresis**

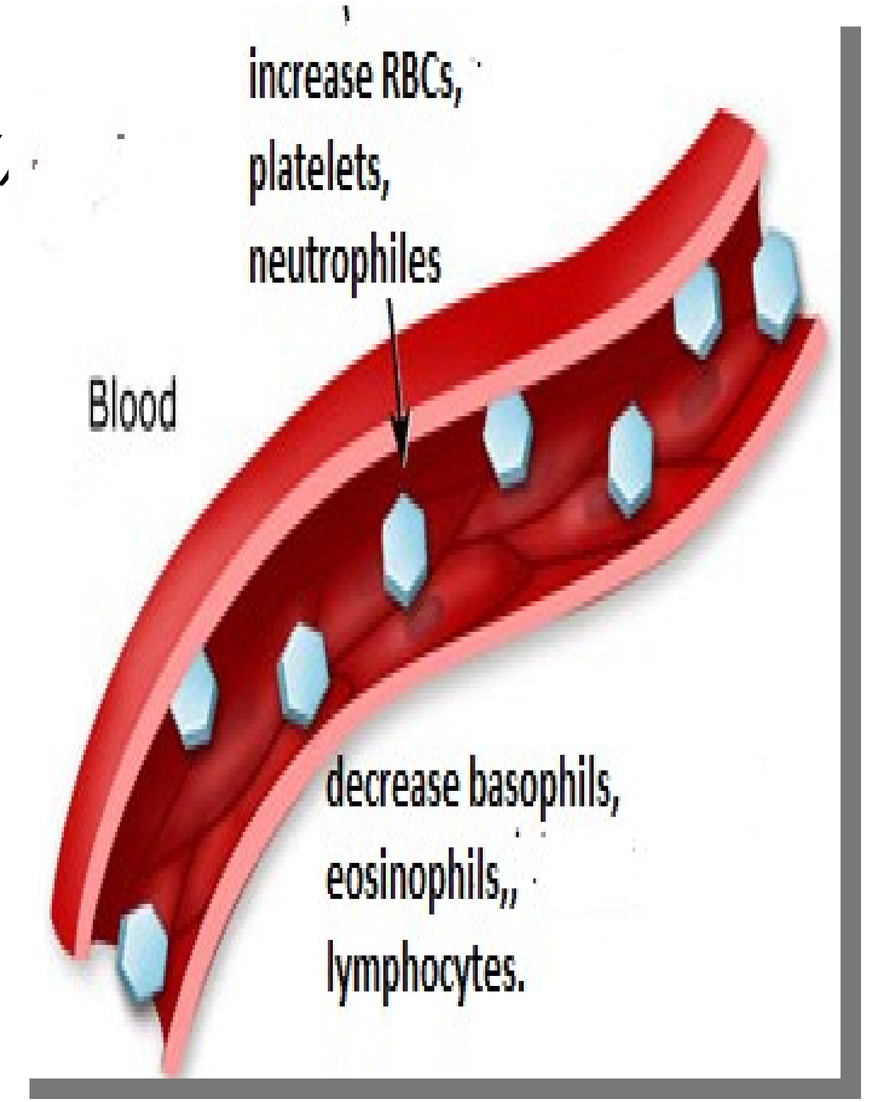


- ↑↑↑ **Slight mineralocorticoid like action** salt & water retention

7- **On blood cells**:

(depression of immunity,

- ↑ RBCs, platelets, neutrophils
- ↓ **B**asophils, **E**osinophils & **L**ymphocytes.



8- <u>On bone</u>: *over long periods*

- **↓ bone formation & ↑ bone resorption □** **osteoporosis.**

- **Why??**

1- **↓** protein synthesis by osteoblasts (catabolic) □ **↓bone formation.**

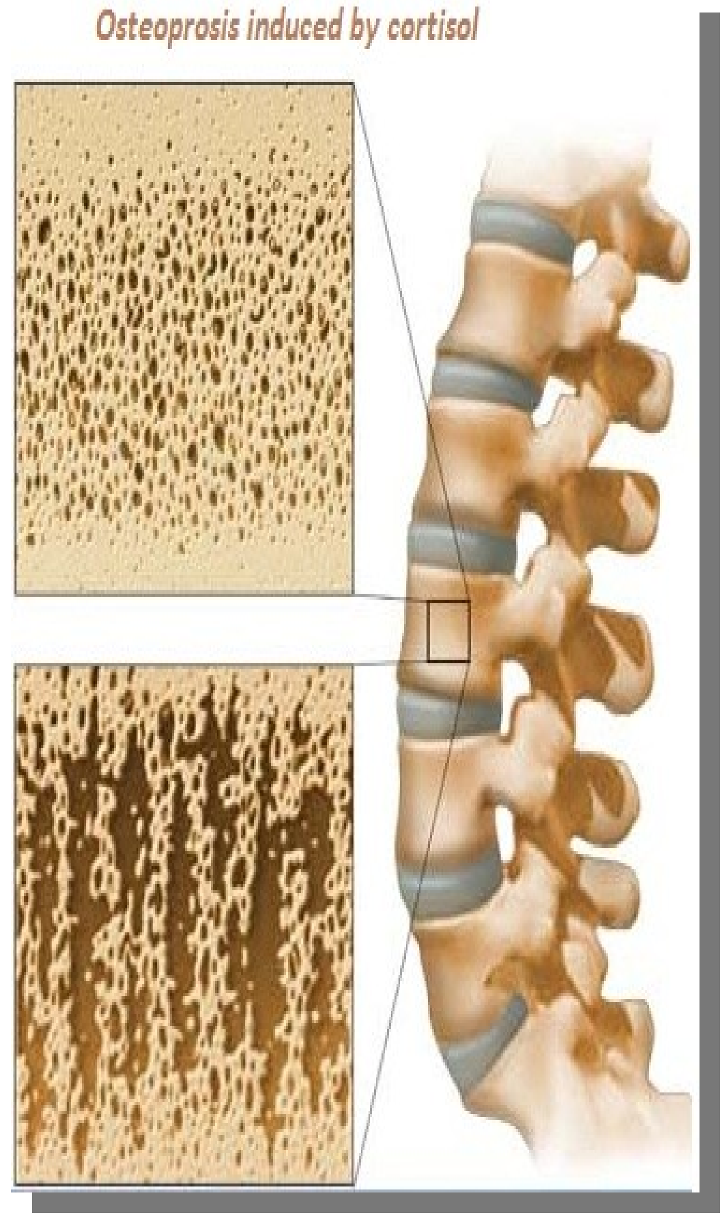
2- **↓** intestinal Ca++, PO4 absorption = anti-vit.D3.

and ↑ renal excretion of Ca++, PO4.

□ ↓ plasma Ca++.

□ (+) PTH.

□ **↑bone resorption.**

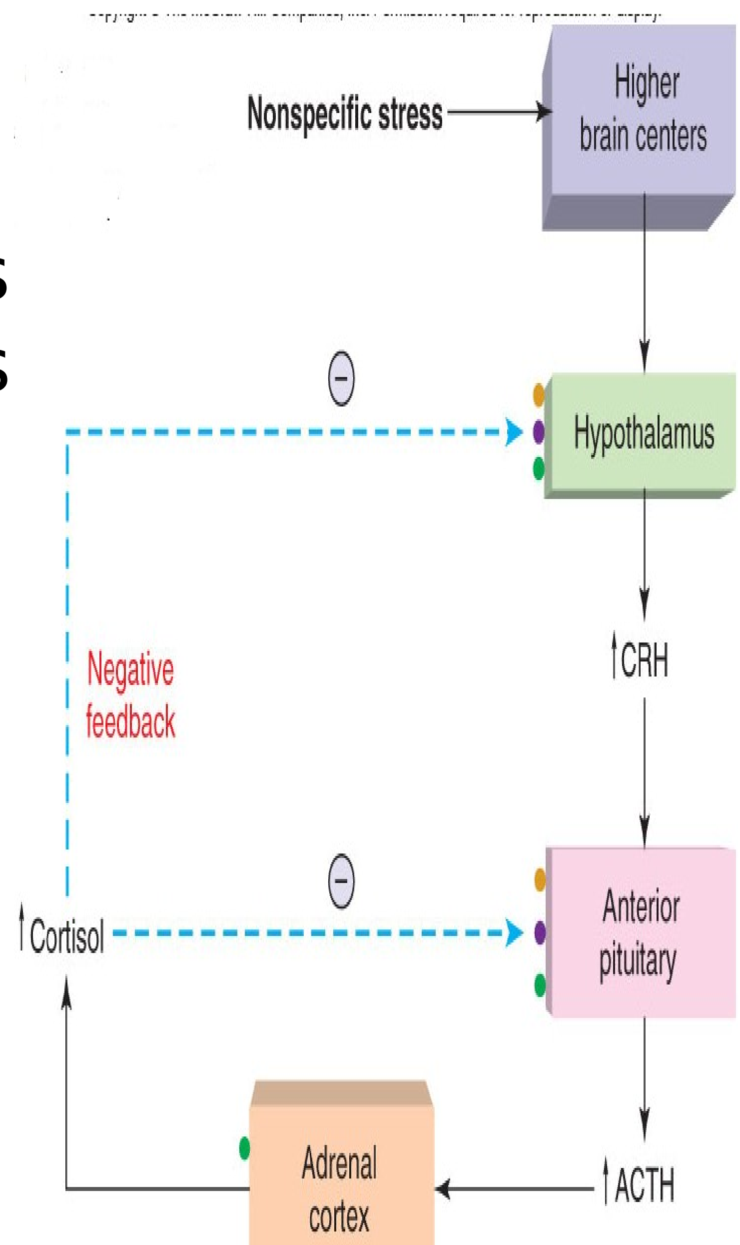


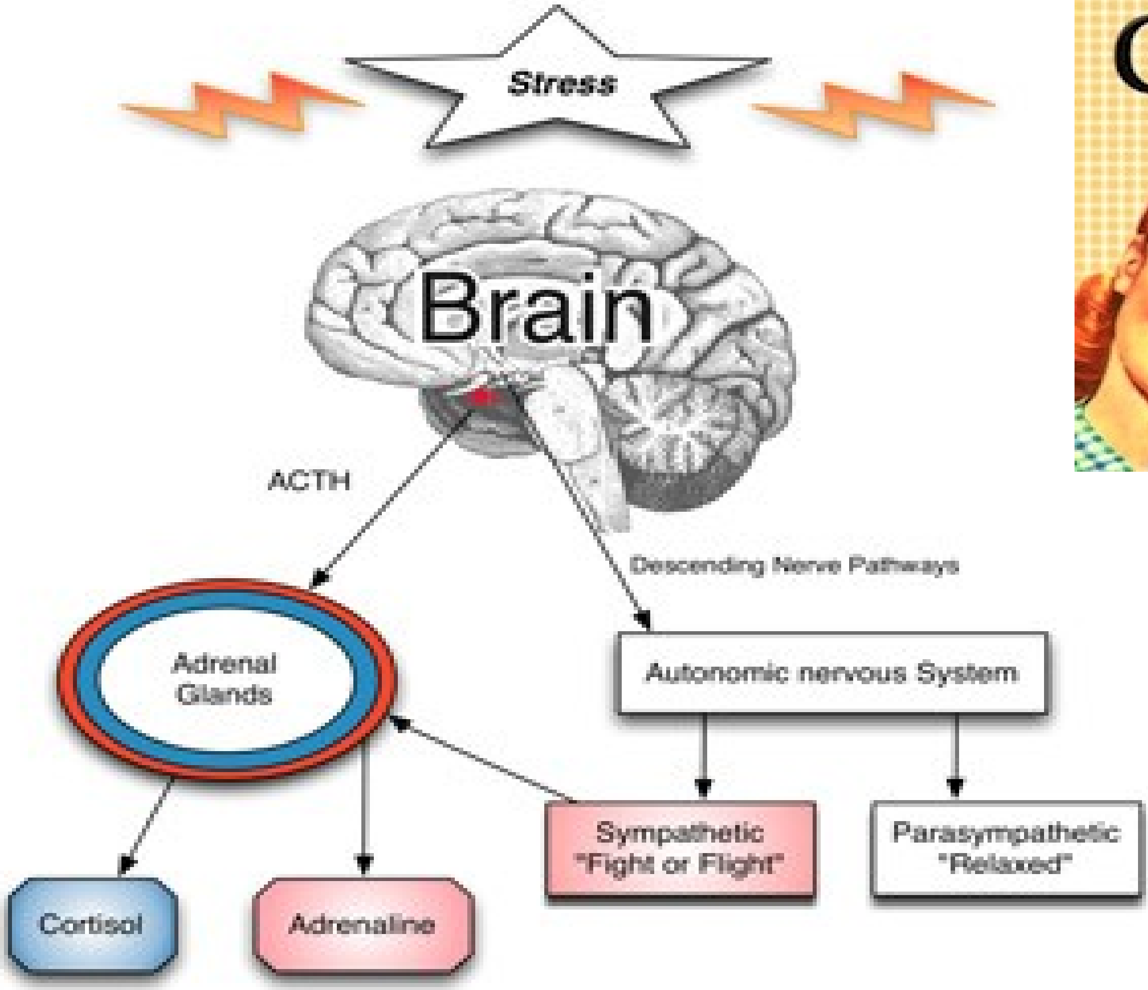
9- **Adaptation to stress**:

Almost any type of stress *(physical or neurogenic)* leads to ↑ in cortisol secretion.

- ↑CRH.
- ↑ACTH secretion.
- ↑ cortisol secretion.

This increase is essential for survival.





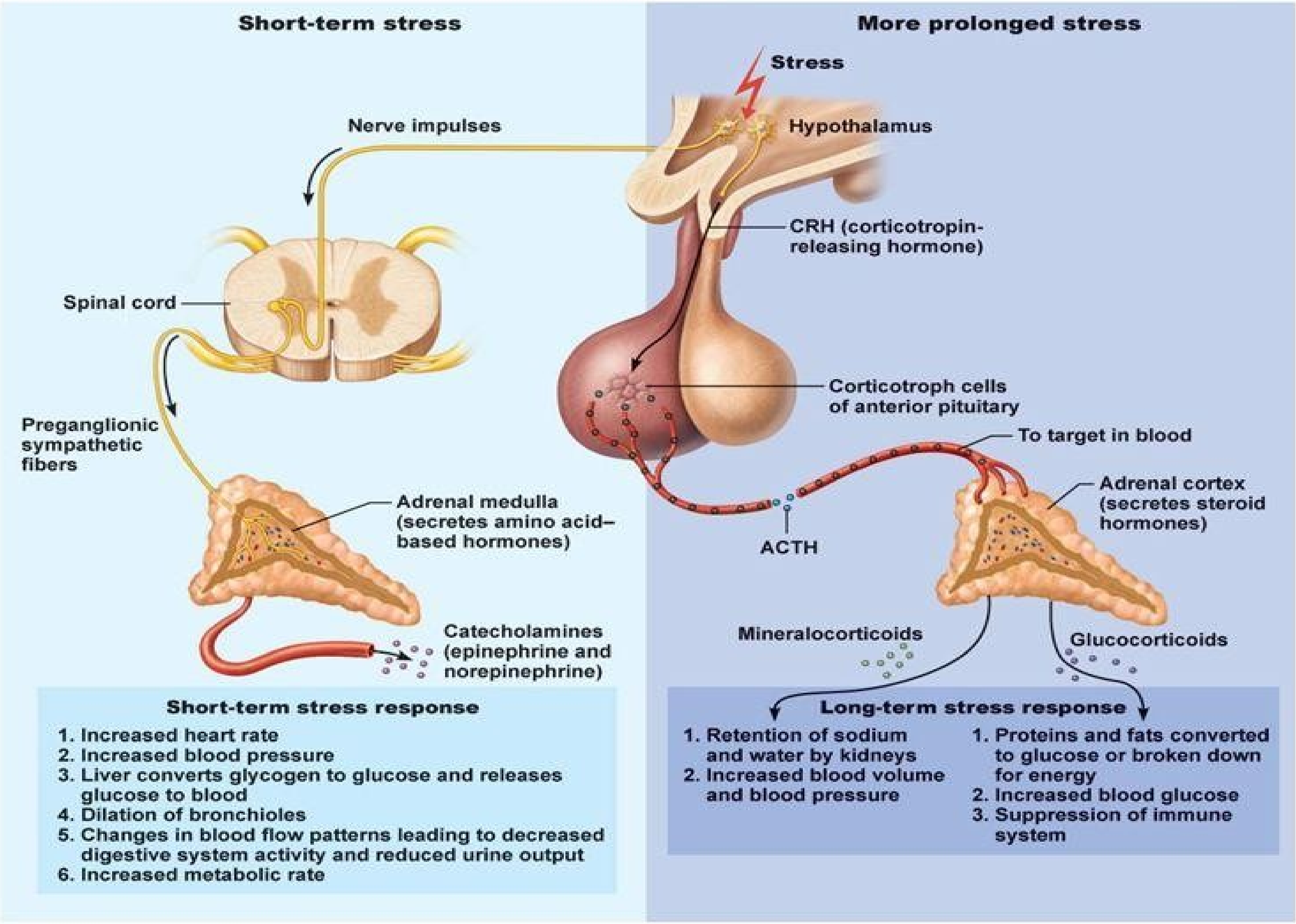




Why cortisol is needed during stress?

Its **metabolic** effects and **permissive** actions on catecholamines help to resist stress

Function of cortisol in stress

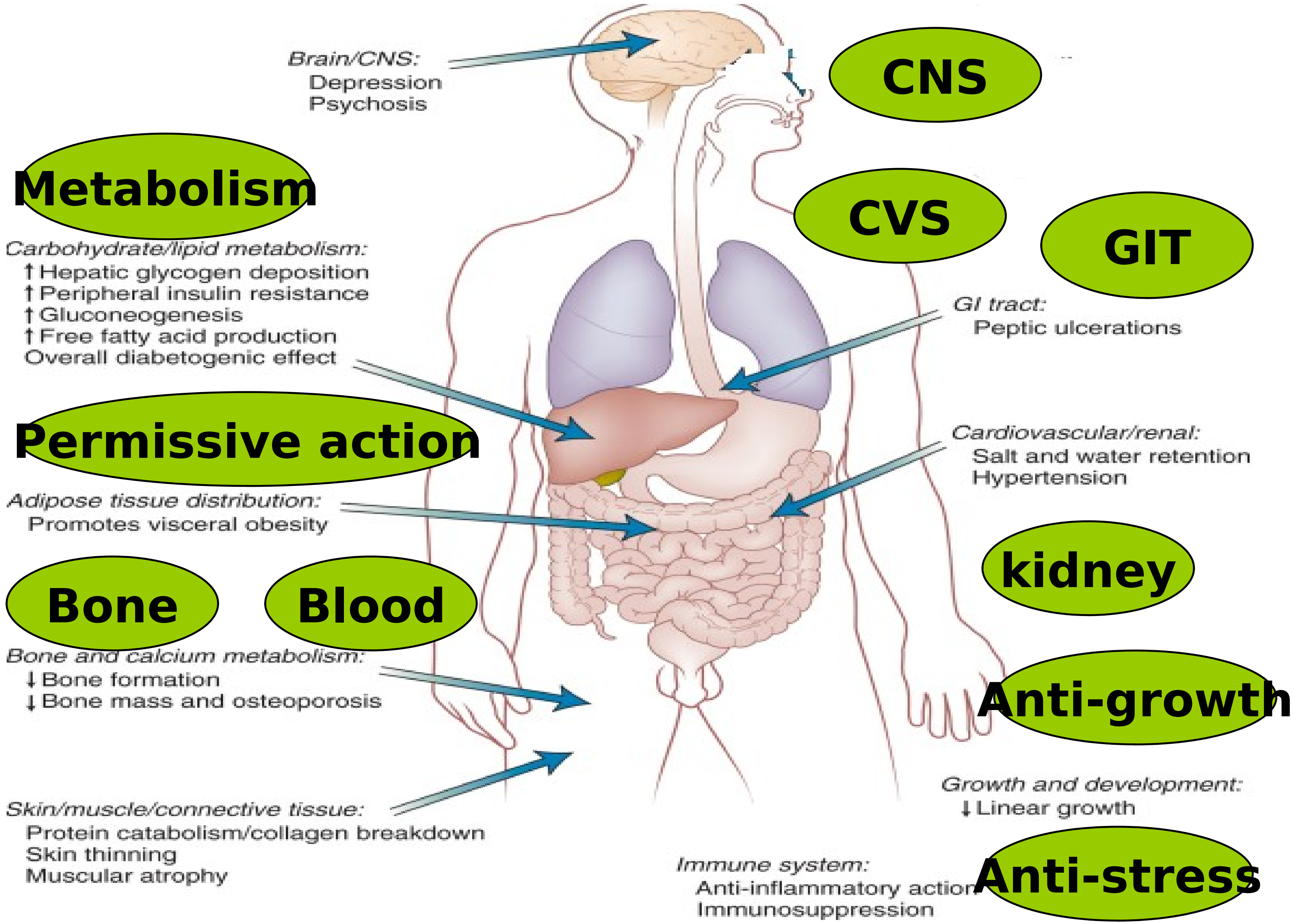


10- **On growth & development:**

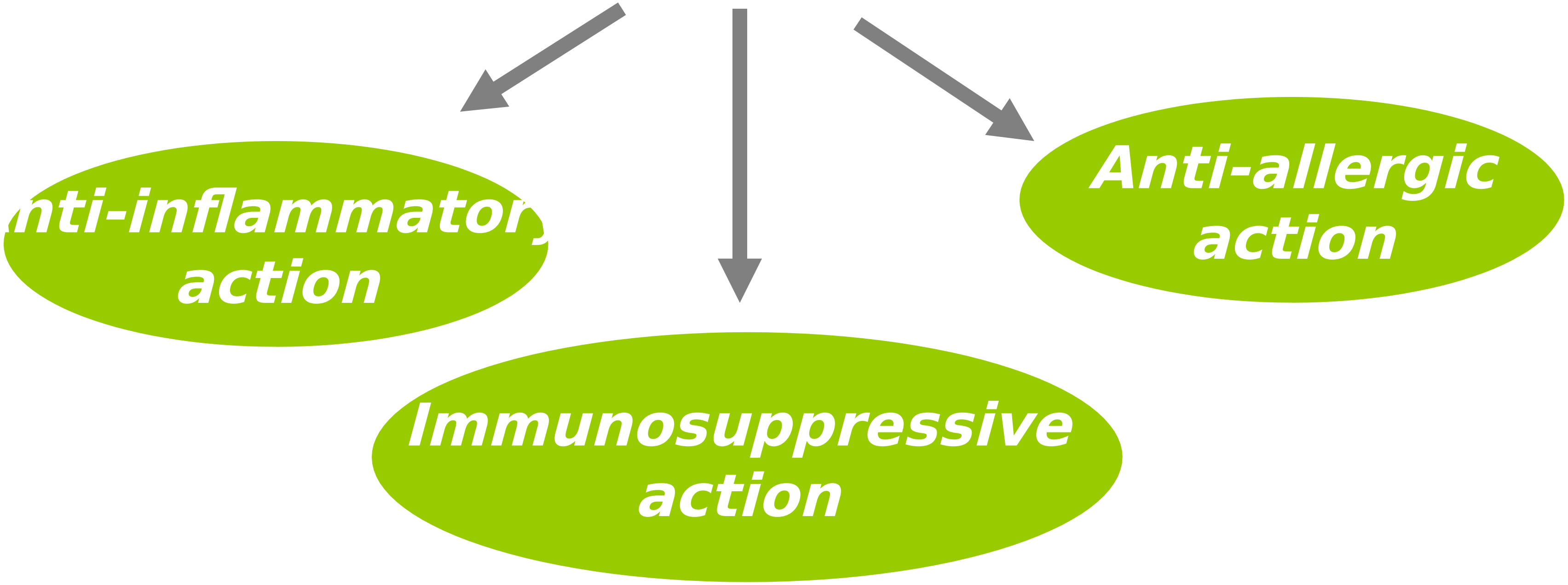
= *Antigrowth effects*

- Suppress growth hormone. **↓ GH**

- Anti vitamin D (antagonize the effect of vit D on Ca++ & P absorption from intestine). **↓ vit. D3**


CNS
Brain/CNS:
Depression
Psychosis
Metabolism
CVS
GIT
Carbohydrate/lipid metabolism:
↑ Hepatic glycogen deposition
↑ Peripheral insulin resistance
↑ Gluconeogenesis
↑ Free fatty acid production
Overall diabetogenic effect
GI tract:
Peptic ulcerations
Permissive action
Cardiovascular/renal:
Salt and water retention
Hypertension
Adipose tissue distribution:
Promotes visceral obesity
kidney
Bone
Blood
Bone and calcium metabolism:
↓ Bone formation
↓ Bone mass and osteoporosis
Anti-growth
Skin/muscle/connective tissue:
Protein catabolism/collagen breakdown
Skin thinning
Muscular atrophy
Growth and development:
↓ Linear growth
Immune system:
Anti-inflammatory action
Immunosuppression
Anti-stress

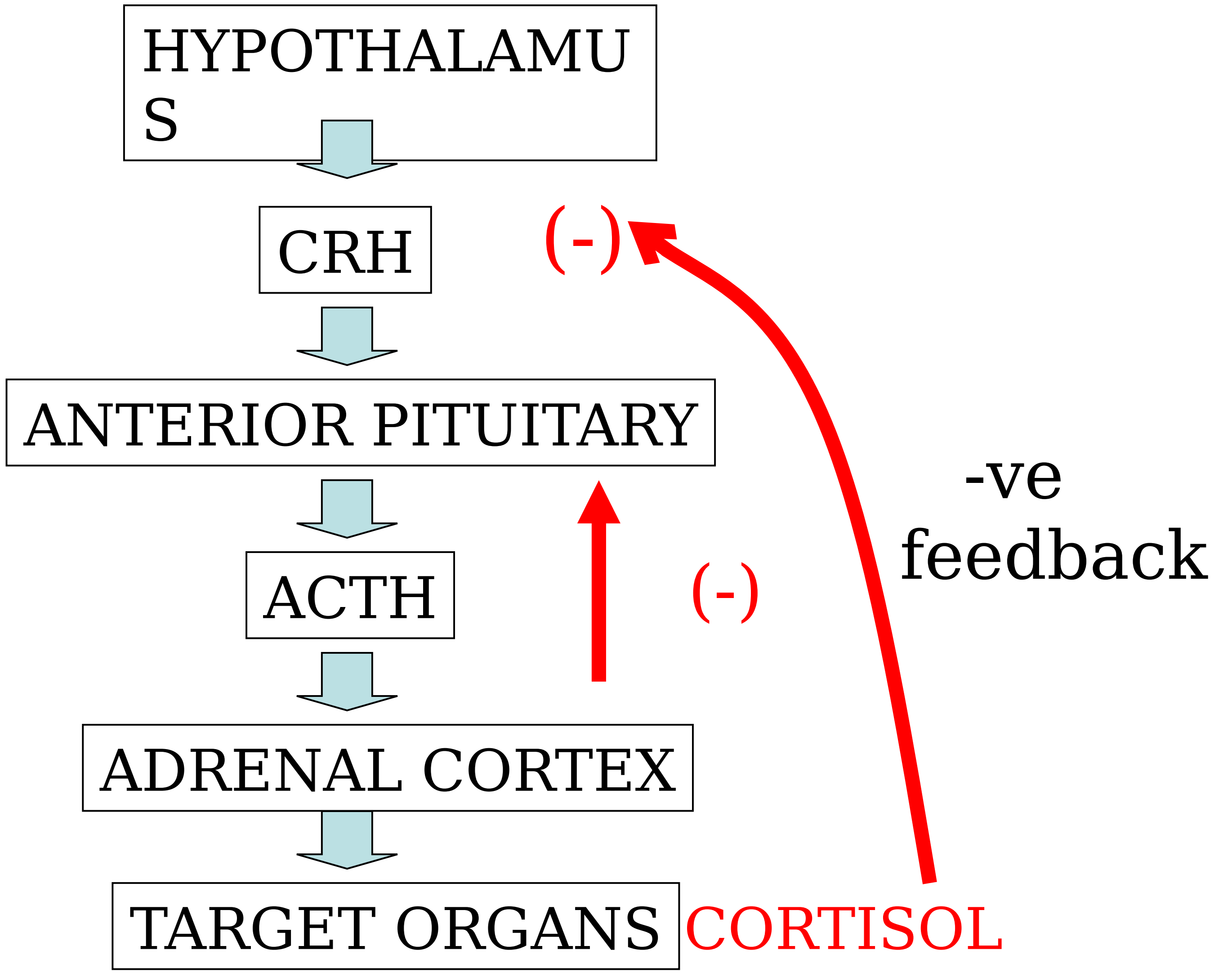
Cortisone as a drug is effective in different medical conditions due its:



- Such as

1. Treating destructive inflammatory conditions e.g. rheumatoid arthritis.
2. Prevention of organ transplant rejections.
3. Management of allergic disorders (e.g bronchial asthma & anaphylaxis).

REGULATION OF CORTISOL SECRETION



REGULATION OF CORTISOL SECRETION

- **Actions of ACTH:**

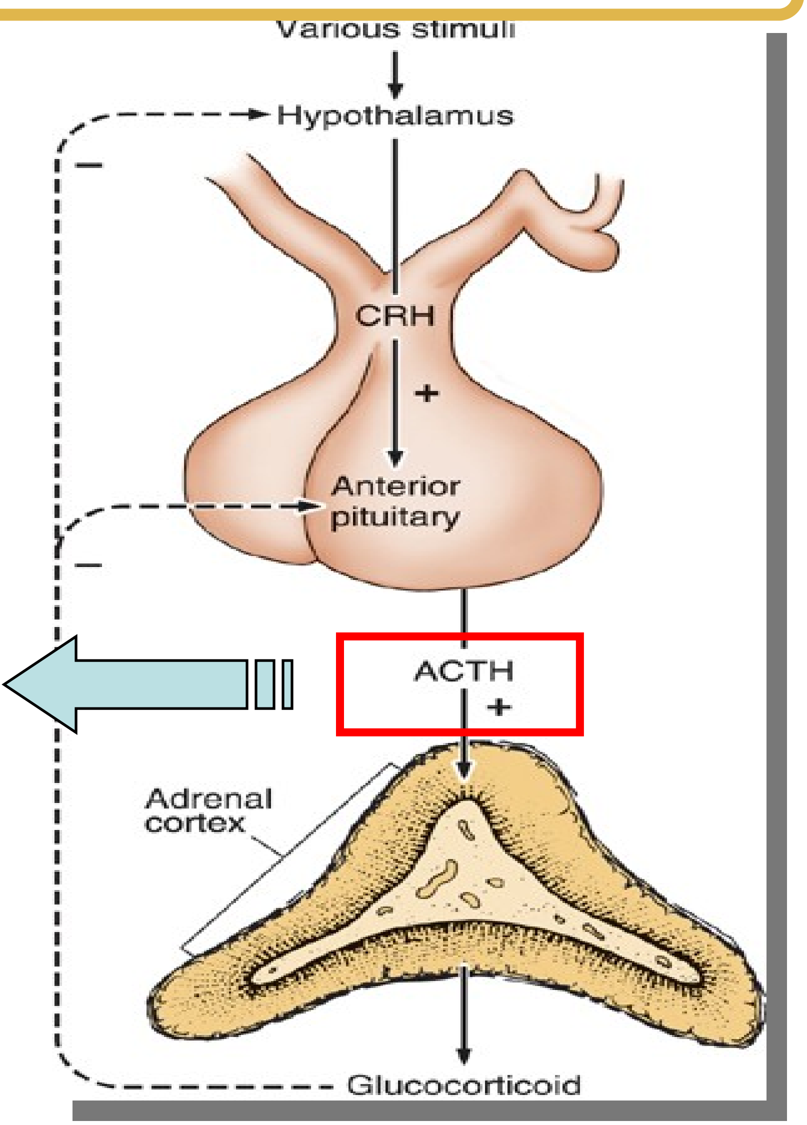
1- ↑ Size & vascularity of gland.

2- (+) cortisol secretion by Z.F.

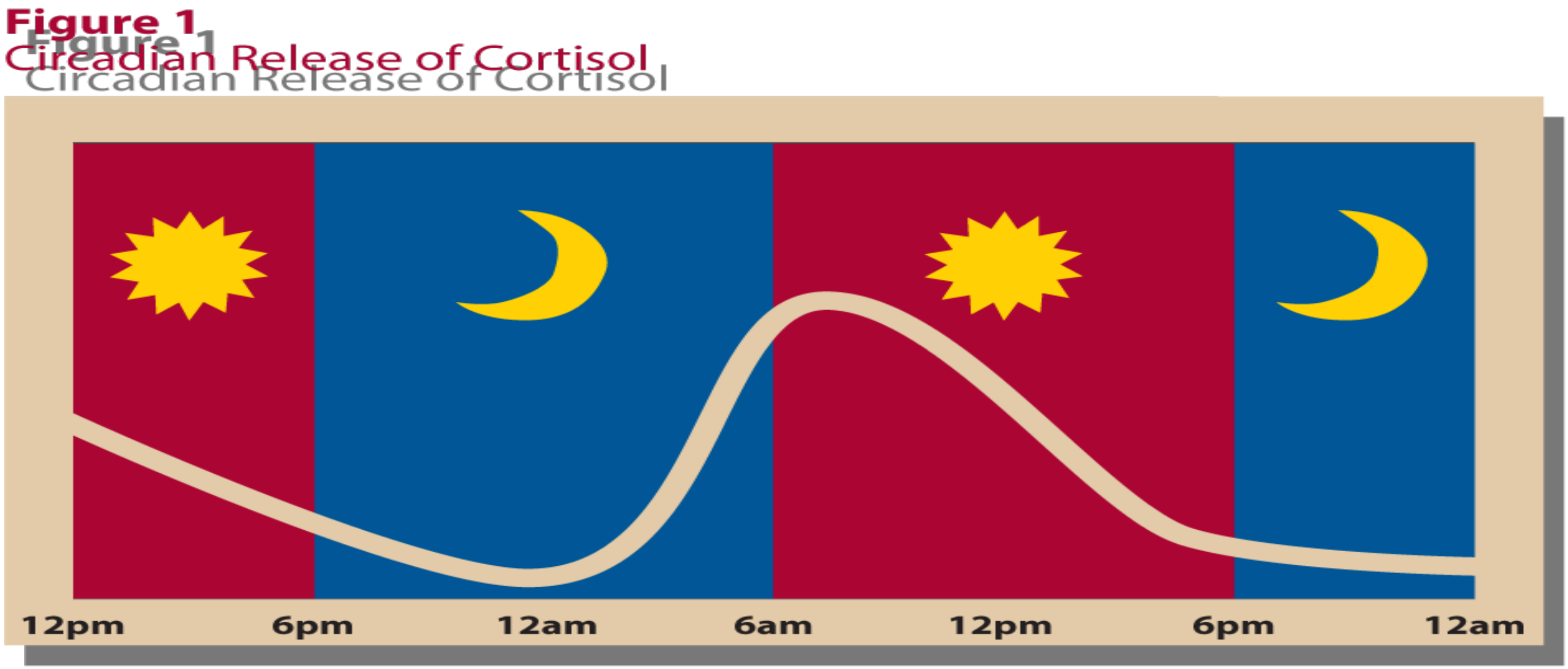
3- (+) androgen secretion by Z.R.

4- Minimal effect on Z.G.

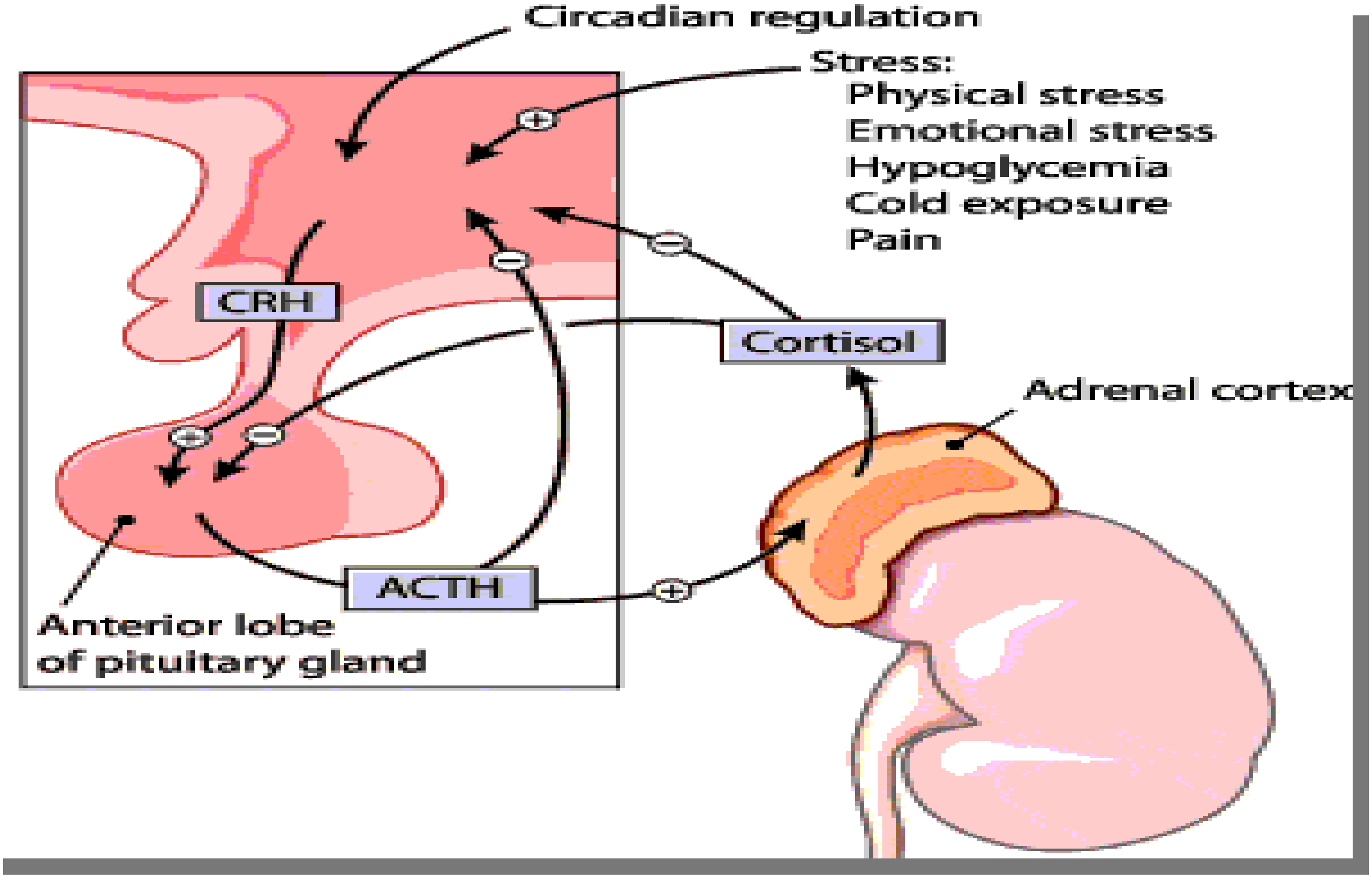
5- MSH like activity skin pigmentation.



- **Circadian rhythm:** = Typical changes in plasma cortisol level that occur over a 24 hour period with the **highest** level at the time of awaking ***in early morning*** and is **lowest** ***in the mid-night.***



- **Stress induced cortisol secretion:**



✓ Hormones released during stress:

1- **Glucocorticoids:** Almost any type of stress, whether physical or neurogenic, causes an immediate and marked increase in ACTH secretion by the anterior pituitary gland, followed within minutes by greatly increased cortisol secretion.

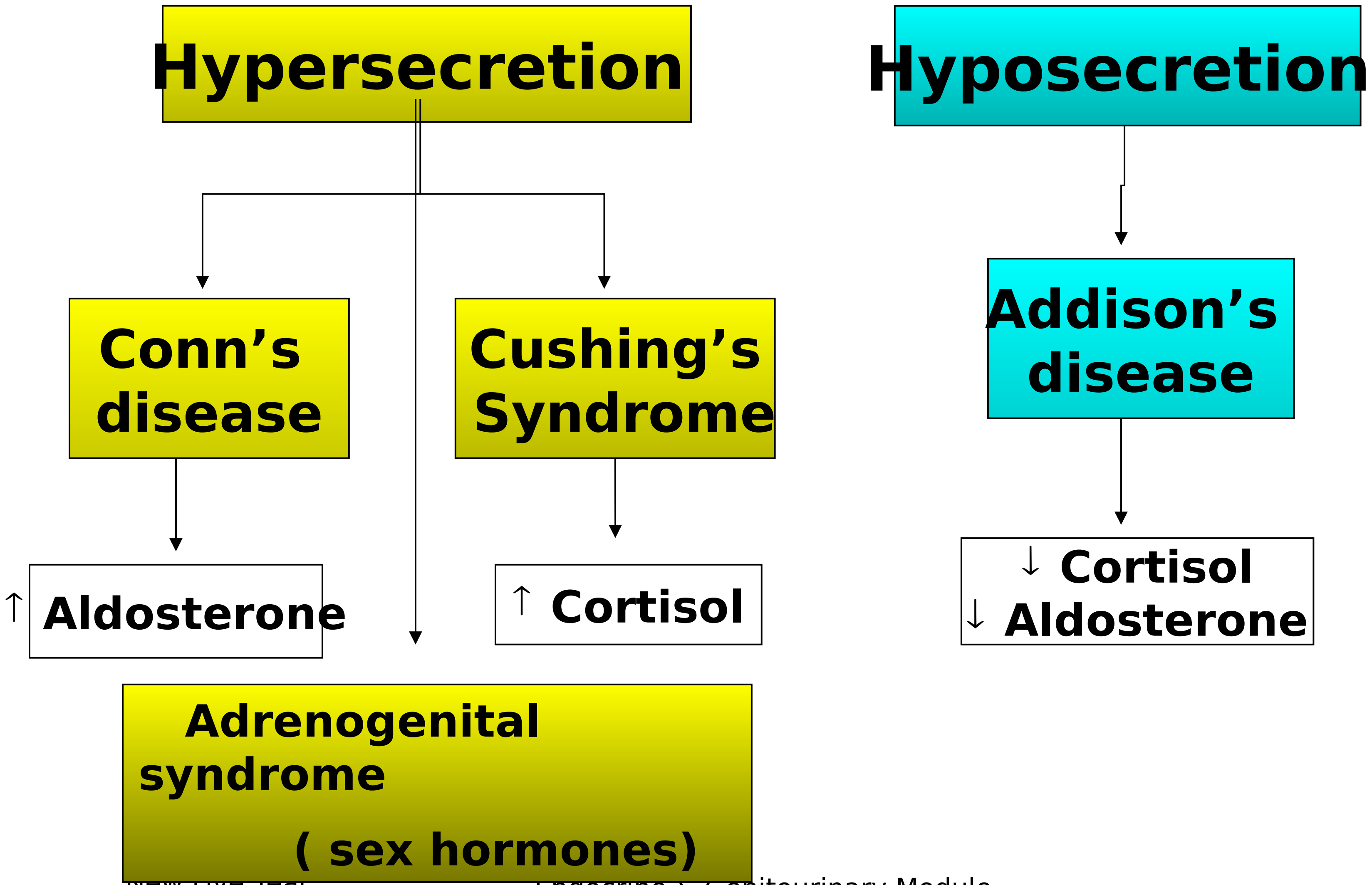
- Some of the different types of stress that increase cortisol release are trauma of almost any type, infection, surgery.

2- **Mineralocorticoids:** are said to be the acute "lifesaving" portion of the adrenocortical hormones, allowing the person to resist the destructive effects of life's intermittent physical and mental "stresses, "

3- **Catecholamines** are equally necessary. See later

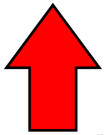
4- Vasopressin, also increases during stress

Disorders of Adrenal Cortex



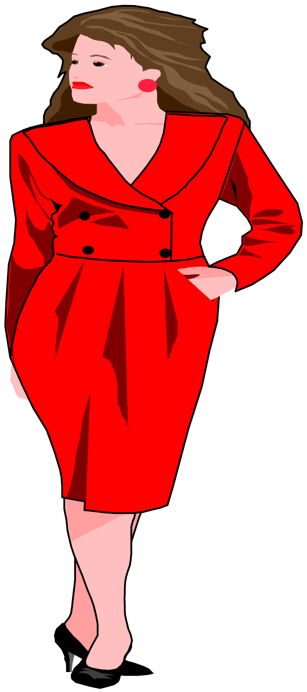
CUSHING'S SYNDROME

(TOO MUCH CORTISOL!)

-  secretion of cortisol from adrenal cortex (z. fasiculata).

- May be accompanied by excess secretion of androgen.

- More frequent in females at age of 30-50.



- **CAUSES:**

1- non ACTH dependent Cushing Syndrome:

- Adrenocortical tumours (adenoma in Z.F)

□□□ cortisol with subsequent suppression of ACTH.

- Prolonged glucocorticoid therapy as in patients with bronchial asthma or rheumatoid artharitis.

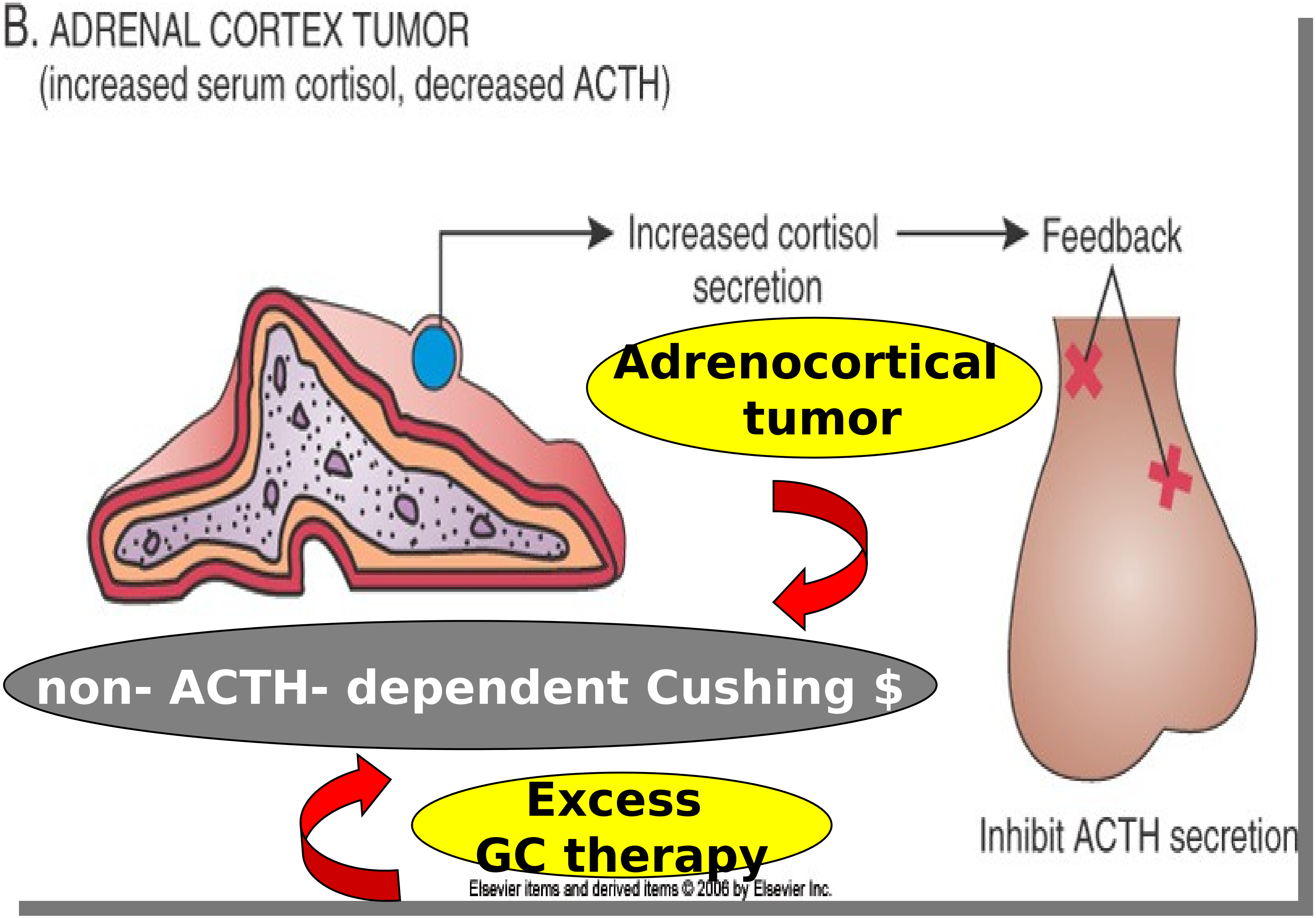
So, **□ cortisol □↓ ACTH**

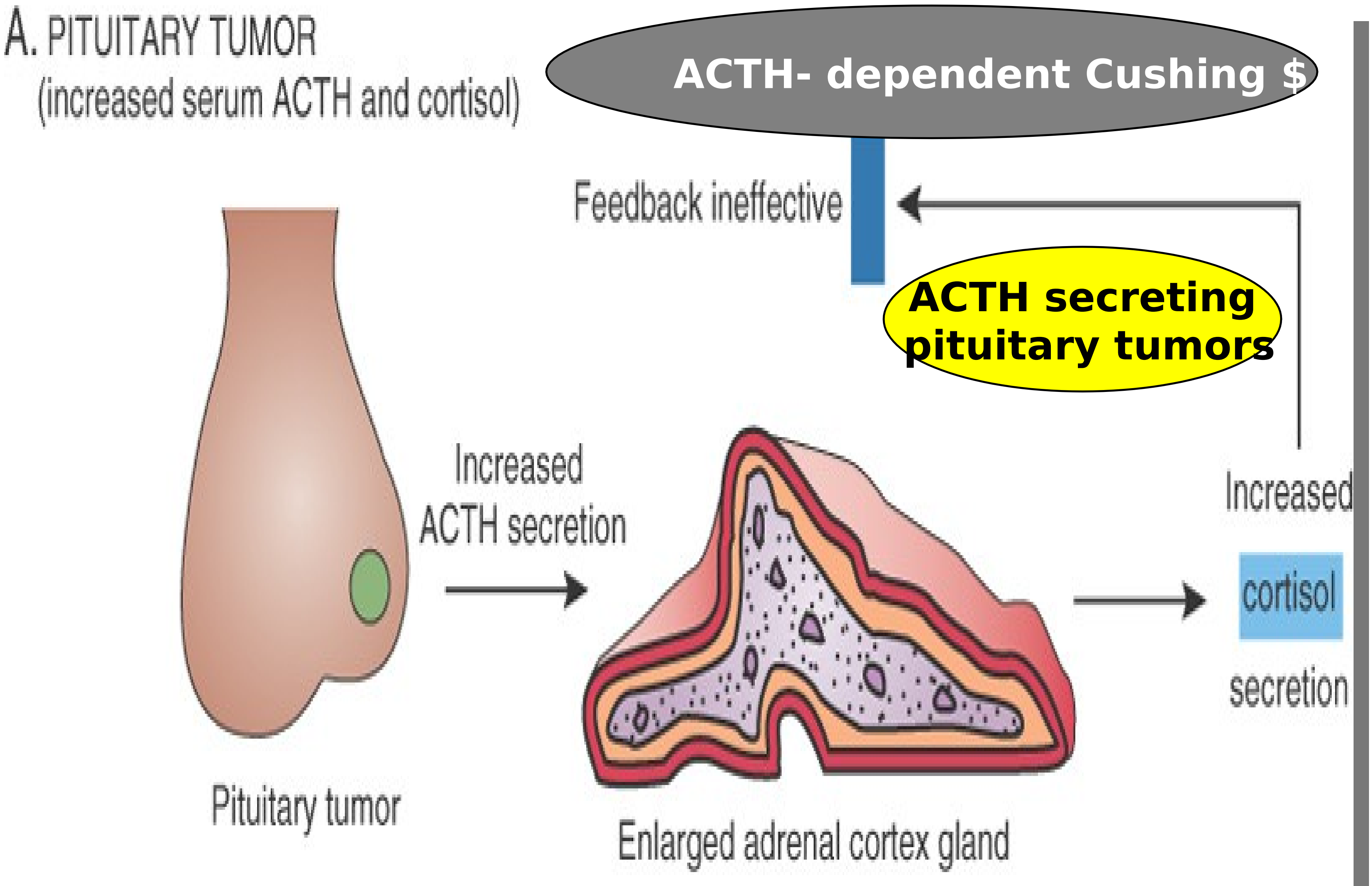
2- ACTH dependent Cushing Syndrome:

- ACTH secreting tumor in anterior pituitary

□□□ cortisol from adrenal cortex.

So, **□ ACTH □ □ cortisol**


B. ADRENAL CORTEX TUMOR
(increased serum cortisol, decreased ACTH)
Increased cortisol secretion
Feedback
Adrenocortical tumor
non- ACTH- dependent Cushing $
Excess GC therapy
Inhibit ACTH secretion
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A. PITUITARY TUMOR
(increased serum ACTH and cortisol)
ACTH- dependent Cushing $
Feedback ineffective
ACTH secreting pituitary tumors
Increased ACTH secretion
Increased
cortisol
secretion
Pituitary tumor
Enlarged adrenal cortex gland

SIGNS & SYMPTOMS:

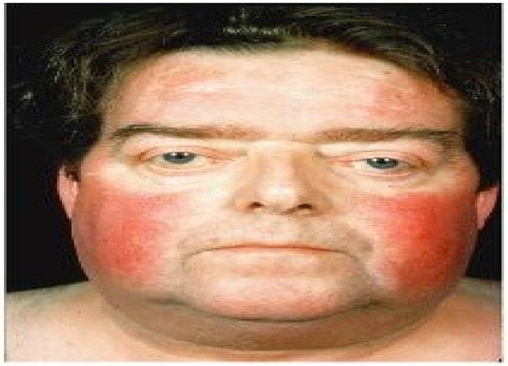
- ↑ **Protein catabolism:**
  - ***Wasting*** of <u>muscles</u> of arms & legs with muscle weakness.
  - Loss of collagen support of <u>skin</u> with exposure of underlying capillaries **reddish striae *(stria rubra)***
  - Delayed & poor wound healing.





- **Disturbances in fat metabolism:**

Redistribution of fat & its deposition in abnormal sites.



- Face rounded , red with drooping of angle of mouth ***"moon face"***



- Trunk & abdomen ***" trunkal obesity"***
- Back of neck & interscapular region ***"buffalo hump".***



- Lemon over watermelon over matchsticks.

- **Disturbances in CHO metabolism:**

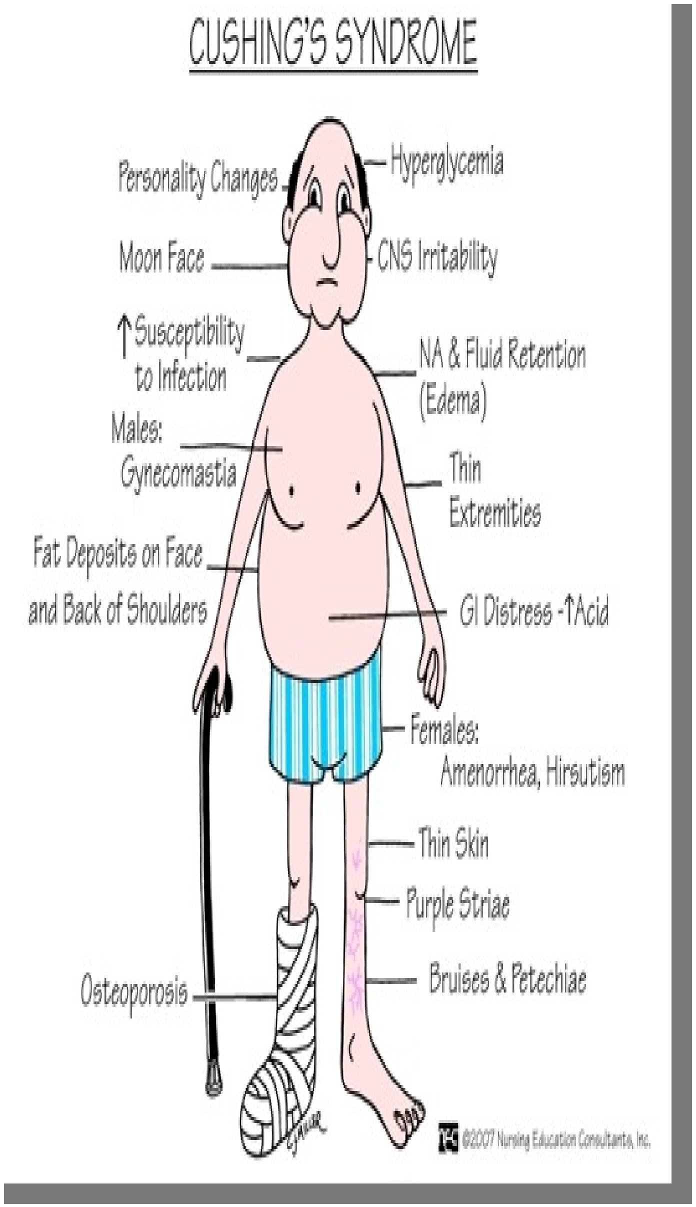
Hyperglycemia adrenal diabetes

- **C.N.S:** Euphoria, insomnia .
- **C.V.S:** Hypertension. ???
- **GIT**: Liability for peptic ulcer.

- **Kidney:**
  Mineralocorticoid activity
  - Salt & water retention hypertension.

- **Blood:**
  - Polycythemia facial plethora.
  - Immune suppression risk of infection.

- ** Androgen secretion**
  - Excessive hair growth (hirsutism).
  - Acne.
  - Change in voice.





Treatment:

Surgical removal of tumour or discontinuation of the drug

Lecture Quiz

Q. Which of the following describes cortisol?

a. inhibits the release of adrenocorticotropic hormone (ACTH) from anterior pituitary.

b. is released with a circadian rhythm so that its blood levels peak at midnight.

c. in normal physiological blood levels has an anti-inflammatory effect.

d. increases bone strength.

e. decreases blood glucose level during fasting.

Lecture Quiz

Q. Which of the following is true about Cushing syndrome?

a. Occurs due to excess secretion of thyroid hormone.
b. Associated with deposition of fat in face, chest and trunk.
c. Associated with excess calcium deposition in bones.
d. Characterized by severe hypoglycemia.
e. Associated with increased immunity.


Thank You
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